

CHAPTER 9

GENERAL HEALTH

INTRODUCTION

The effects of heavy, acute exposure to TCDD have been demonstrated in a number of different organ systems. It is plausible, therefore, that chronic low-dose exposure to TCDD might induce subtle, interrelated effects that are not organ-system specific, but are manifest only in general terms, or affect the state of "well-being." However, it is difficult to measure overall health objectively, and for this reason general health outcomes, as defined by this study, should be judged in context with other more specific clinical endpoints. (It should be noted that "general health" outcomes have not traditionally been considered in other dioxin morbidity studies.)

Baseline Summary Results

Five general health variables were included in the Baseline examination: self-perception of health, appearance of illness or distress, relative age, sedimentation rate, and percent body fat. In the analysis of the 1982 Baseline examination data, a statistically significant difference was found between the Ranch Hand and Comparison groups in self-perception of health, with a greater percentage of Ranch Hands reporting their health as fair or poor than Comparisons. This was true in both the younger and older age groups ($p=0.017$ and $p=0.025$ for individuals 40 or less and more than 40 years of age, respectively). The relative risk of the Ranch Hand group was also somewhat greater in the younger subgroup than in the older subgroup (1.8 and 1.4, respectively). Since only 9 of 1,811 individuals were reported by the examining physician as appearing ill or distressed, this designation was apparently reserved for only very ill or distressed individuals. Nevertheless, 8 of the 9 individuals were Ranch Hands, the difference being of borderline significance ($p=0.056$). Conversely, more Ranch Hands than Comparisons were reported by the examiners as appearing younger than their actual ages (4.9% versus 2.5%, $p=0.029$). No overall differences in percent body fat or sedimentation rate were found, although a significant interaction between age, group, and sedimentation rate was noted; younger exposed group members had fewer sedimentation rate abnormalities than did their Comparisons, whereas no difference was found in participants more than 40 years old. No statistically significant dose-response relationships were detected in the Ranch Hand group.

Parameters of the 1985 General Health Assessment

Variables of the Baseline examination (self-perception of health, appearance of illness or distress, relative age, sedimentation rate, and percent body fat) were analyzed for the third year followup effort.

As an assessment of the general health status of each individual, three subjective measures were made as well as two more objective measures. During the health interview each study participant was asked, "Compared to other people your age, would you say that your health is excellent, good, fair, or poor?" This self-assessment of health is susceptible to varying degrees of conscious and subconscious bias. The examiner recorded the appearance of illness or distress (yes/no) and noted the appearance of the subject as younger than, older than, or the same as his stated age. To the degree that the examining physicians were kept blind to the study subject's group membership (Ranch Hand, Comparison), their assessments were less subject to bias.

The two objective measures were percent body fat, calculated from the body mass index, and the erythrocyte sedimentation rate. Although both variables are rather indirect measures of the general state of health, they are accepted indicators of poor health.

The adjusted statistical analyses below accounted for differences associated with age, race, and occupation. In the analysis of self-perception of health and sedimentation rate, adjustment was also made for personality score, determined from the Jenkins Activity Survey.¹ This is a continuous variable derived by means of a discriminant-function equation based on items that best discriminate men judged to be Type A from those judged as Type B. Positive scores reflected the Type A direction and negative scores the Type B direction. Table G-1 of Appendix G gives the distribution of the covariates in the Ranch Hand and Comparison groups. Age, race, and occupation were distributed similarly in the two groups (due to matching), and personality scores were also not significantly different.

Aside from the subjective nature and potential bias in the self-reported perception of health, no specific issues related to assessment methodology require further comment. No individuals were excluded from analysis, except those with missing data.

Chi-square tests and logistic regression models were applied to the categorical data. The sedimentation rate was normalized by logarithmic transformation. The proportional odds model was also used for ordinal data provided by the self-perception of health and relative age variables. Fisher's exact test was applied to the reporting of illness or distress by the examining physician because of the small number of cases who were classified as "ill." A two-sample t-test was used to assess differences in unadjusted group means, followed by multiple regression analysis to incorporate covariates, for percent body fat and sedimentation rate.

RESULTS AND DISCUSSION

Subjective Assessments

Self-Perception of Health

Each participant was asked to designate his health as excellent, good, fair, or poor. The frequency distributions of self-perception of health for each cohort are given in Table 9-1.

TABLE 9-1.

**Unadjusted Analysis for Self-Perception
of Health by Group**

Group	Self-Perception of Health								Total
	Excellent		Good		Fair		Poor		
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Ranch Hand	490	48.2	434	42.7	74	7.3	18	1.8	1,016
Comparison	674	52.1	525	40.6	81	6.3	13	1.0	1,293
p=0.14									

The summarized data in Table 9-1 show that a higher percentage of Ranch Hands perceived their health to be fair or poor (9.1%) than the Comparisons (7.3%), although this difference was not statistically significant (Est. RR: 1.25, 95% C.I.: [0.95, 1.64], $p=0.14$). Of considerable interest is that the percentage of both groups perceiving their health as only fair or poor was lower than that reported at the Baseline examination 3 years earlier (20.4% and 15.9% for Ranch Hands and Comparisons, respectively). This shift was the opposite of that expected from an aging effect. The data collection technique was an in-home interview in 1982 versus an onsite clinic interview in 1985, but this was not judged to be the likely cause of the improvement in health perceptions for the 3-year period. Whatever the cause, the effects were similar in both groups.

A test of association between health perception (dichotomized as excellent/good and fair/poor) was performed with the covariates of age (born in or after 1942, born before 1942), race, occupation, and personality score (Jenkins score, trichotomized as low [less than -5], medium [between -5 and 5], and high [greater than 5]). These associations were examined both within the Ranch Hand and Comparison groups and pooled over the two groups. The findings were similar, and Table 9-2 shows the results after pooling.

These results indicated a significant effect of age, with a higher percentage of the older cohort than the younger cohort reporting their health as fair or poor, as well as a significant effect of occupation, with the percentage of enlisted personnel reporting fair or poor health nearly twice that of the officers. No significant associations were noted for race or personality score.

TABLE 9-2.

Association Between Self-Perception of Health and
Age, Race, Occupation, and Personality Score in the
Combined Ranch Hand and Comparison Groups

Covariate	Covariate Category	Self-Perception of Health				Total	p-Value
		Excellent/Good		Fair/Poor			
		Number	Percent	Number	Percent		
Age	Born \geq 1942	903	94.0	58	6.0	961	0.003
	Born $<$ 1942	1,220	90.5	128	9.5	1,348	
Race	Black	130	90.9	13	9.1	143	0.76
	Nonblack	1,993	92.0	173	8.0	2,166	
Occupation	Officer	819	94.8	45	5.2	864	<0.001
	Enlisted						
	Flyer	347	89.7	40	10.3	387	
	Enlisted Groundcrew	957	90.4	101	9.6	1,058	
Person- ality Score	Low	827	92.2	70	7.8	897	0.61
	Medium	716	91.2	69	8.8	785	
	High	573	92.6	46	7.4	619	

Adjusted analyses of self-perception of health were done by logistic regression using the covariates of age, race, occupation, and personality type. (Self-perception of health was dichotomized and the covariates categorized as in Table 9-2.) These analyses revealed statistically significant age and occupation effects, as well as a significant group-by-occupation interaction ($p=0.015$). Exponentiation of linear combinations of relevant regression coefficients generated adjusted relative risks for each occupational stratum. These summary data are presented in Table 9-3.

TABLE 9-3.

Adjusted Relative Risks of Self-Perception
of Health by Occupation

Occupation	Adj. Relative Risk (95% C.I.)	p-Value
Officer	0.78 (0.42,1.46)	0.441
Enlisted Flyer	0.75 (0.38,1.46)	0.395
Enlisted Groundcrew	1.90 (1.25,2.88)	0.003

These analyses showed significant group differences in the self-perception of health for the enlisted groundcrew category but not for the officers or enlisted flyers. This is perhaps more clearly seen in Table 9-4, which gives the frequency distribution of self-perception of health stratified by occupation.

Among officers and enlisted flyers, a lower percentage of Ranch Hands than Comparisons perceived their health as fair or poor. (These same Ranch Hands were also less likely to view their health as excellent.) In the enlisted groundcrew cohort, 12.7 percent of the Ranch Hands reported their health as fair or poor versus 7.2 percent of the Comparisons.

Because the logistic model does not account for the ordinal nature of the self-perception of health variable, a proportional odds model for ordinal responses was also fit to the data in Tables 9-1 and 9-4.

For the ordinal responses in Table 9-1, the proportional odds model yielded a statistically significant result ($p=0.037$), with poorer health estimated to be 1.18 times greater in the Ranch Hand group than in the Comparison group (95% C.I.: [1.01,1.39]). For the data in Table 9-4, a proportional odds model fit to each occupational stratum (adjusting for age) yielded p-values of 0.65 for officers, 0.43 for enlisted flyers, and 0.031 for enlisted groundcrew. Thus, only the enlisted groundcrew category reached statistical significance, with adjusted proportional odds of 1.30 (95% C.I.: [1.02,1.64]).

TABLE 9-4.

Frequency of Self-Perception of Health
by Occupation and Group

Occupation		Self-Perception of Health								Total
		Excellent		Good		Fair		Poor		
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
<hr/>										
Officer										
Ranch Hand	238	62.6	124	32.6	13	3.4	5	1.3	380	
Comparison	314	64.9	143	29.6	23	4.8	4	0.8	484	
<hr/>										
Enlisted Flyer										
Ranch Hand	67	37.8	94	53.1	13	7.3	3	1.7	177	
Comparison	94	44.8	92	43.8	19	9.0	5	2.4	210	
<hr/>										
Enlisted Groundcrew										
Ranch Hand	185	40.3	216	47.1	48	10.5	10	2.2	459	
Comparison	266	44.4	290	48.4	39	6.5	4	0.7	599	
<hr/>										

Similar results were obtained when the analyses were performed on the 1,016 Ranch Hands and 955 Original Comparisons completing the third-year health interview. These results are provided in Table G-2 of Appendix G. In the unadjusted analysis, the estimated relative risk for fair or poor health versus excellent or good health reached statistical significance (Est. RR: 1.43, 95% C.I.: [1.03,2.00], $p=0.042$). In the adjusted analysis, group membership, age, and occupation effects were all statistically significant with an adjusted relative risk of 1.48 (95% C.I.: [1.05,2.07]). The group-by-occupation interaction, however, did not reach statistical significance ($p=0.23$). Nevertheless, little difference was seen in the officers and enlisted flyers, whereas among the enlisted groundcrew, 12.7 percent of the Ranch Hands versus 7.4 percent of the Original Comparisons reported their health as fair or poor.

Contrasts of the Ranch Hand and Original Comparison groups using the proportional odds model yielded only borderline significant results. For the unadjusted analysis applied to the overall data, the estimated proportional odds were 1.17 (95% C.I.: [0.99,1.39], $p=0.073$). Stratifying by occupation and adjusting for age gave p -values of 0.76, 0.11, and 0.078 for the officers, enlisted flyers, and enlisted groundcrew, respectively. The adjusted proportional odds in the enlisted groundcrew cohort were 1.26 (95% C.I.: [0.97,1.62]).

Appearance of Illness or Distress

The recording of the appearance of acute ill health or physical distress at the examination was intended to capture significant subjective health data that might (though not likely) escape corroboration by other physical examination or laboratory data. In particular, examining physicians were requested to affirm the presence of acute distress when the sign of hippocratic facies was present, a sign not easily feigned by participants. Very few participants were diagnosed as being acutely ill; these data are summarized in Table 9-5.

TABLE 9-5.

Unadjusted Analysis for Appearance of Acute Illness or Distress by Group

Group	Acute Illness or Distress				Total	p-Value*
	Yes		No			
	Number	Percent	Number	Percent		
Ranch Hand	4	0.4	1,010	99.6	1,014	0.53
Comparison	6	0.5	1,287	99.5	1,293	

*Fisher's exact test, 1-sided.

These data were too sparse to permit further meaningful analyses. Descriptively, it was noted that 9 of the 10 ill individuals were in the older age group; 9 of 10 were nonblack; and 2 were officers, 4 were enlisted flyers, and 4 were enlisted groundcrew. The 6 ill Comparison individuals were all Original Comparisons, as can be seen in Table G-3 of Appendix G.

Further, these results were in substantial contrast to the Baseline findings that revealed a marginally significant excess ($p=0.056$) of acute distress among the Ranch Hands.

Appearance of Relative Age

The examining physicians scored each participant as appearing younger, older, or the same as his chronological age. These data are presented in Table 9-6.

TABLE 9-6.

Unadjusted Analysis for Appearance of
Relative Age by Group

Group	Appearance of Relative Age						Total	p-Value
	Younger		Same		Older			
	Number	Percent	Number	Percent	Number	Percent		
Ranch Hand	16	1.6	957	94.3	42	4.1	1,015	0.12
Comparison	9	0.7	1,233	95.4	51	3.9	1,293	

These frequency distributions showed that a slightly higher percentage of Ranch Hands than Comparisons appeared younger than their stated age, and almost equivalent percentages in both groups appeared older. Overall, there was no significant difference in the two distributions. The unadjusted findings in Table 9-6, however, did not confirm the significant tendency ($p=0.029$) at the 1982 Baseline examination for a higher percentage of the Ranch Hands than Comparisons to appear younger than their stated ages. Table 9-7 presents the association between each of the covariates and relative age (dichotomized as older looking versus the same or younger looking) after combining the Ranch Hand and Comparison groups.

As noted from this table, age and race were not significantly associated with the appearance of relative age, whereas occupation did reveal a significant association, with about 6 percent of the enlisted personnel appearing older than their stated ages compared to 1 percent of the officers.

An adjusted analysis using logistic regression with the covariates age, race, and occupation showed a significant effect due to occupation as well as a significant group-by-occupation interaction ($p=0.038$). Adjusted relative risks for each occupational stratum are given in Table 9-8.

The adjusted relative risk was greater than 1 for the officers, i.e., the odds of appearing older were greater in the Ranch Hand group than in the Comparison group, but the relative risk was less than 1 for the enlisted flyers. However, the associated confidence intervals were rather broad and did not rule out a relative risk of 1 in each case. Again, because the logistic regression model does not account for the ordinal nature of the dependent variable, a proportional odds model was applied to the enlisted flyer cohort (data in the officer and enlisted groundcrew strata did not fit the model properly). The estimated proportional odds for the enlisted flyer cohort were nonsignificant (estimated odds: 0.49, 95% C.I.: [0.22, 1.11], $p=0.087$).

TABLE 9-7.

**Association Between Appearance of Relative Age and Age,
Race, and Occupation in the Combined
Ranch Hand and Comparison Groups**

Covariate	Covariate Category	Appearance of Relative Age				Total	p-Value
		Younger/Same		Older			
		Number	Percent	Number	Percent		
Age	Born \geq 1942	914	95.2	46	4.8	960	0.14
	Born <1942	1,301	96.5	47	3.5	1,348	
Race	Black	138	96.5	5	3.5	143	0.91
	Nonblack	2,077	95.9	88	4.1	2,165	
Occupation	Officer	855	99.0	9	1.0	864	<0.001
	Enlisted	362	93.5	25	6.5	387	
	Flyer						
	Enlisted Groundcrew	998	94.4	59	5.6	1,057	

TABLE 9-8.

**Adjusted Relative Risks of Appearance of
Relative Age by Occupation**

Occupation	Adj. Relative Risk (95% C.I.)	p-Value
Officer	4.52 (0.94,21.9)	0.060
Enlisted Flyer	0.44 (0.23,1.27)	0.159
Enlisted Groundcrew	1.05 (0.62,1.78)	0.849

A contrast of the Ranch Hand group with the Original Comparisons gave similar results, as shown in Table G-4 of Appendix G. Overall, there was little difference, but the group-by-occupation interaction was of borderline significance in the adjusted analysis ($p=0.052$). Differences were largely confined to the enlisted flyers, where fewer Ranch Hands than Comparisons appeared older than their stated ages (Adj. RR: 0.47, 95% C.I.: [0.20,1.12], $p=0.089$) (see Table G-5 of Appendix G). A proportional odds model applied to the enlisted flyer stratum gave adjusted proportional odds of 0.45 (95% C.I.: [0.20,1.02], $p=0.055$).

Objective Assessments

Two objective but nonspecific indicators of general health, the erythrocyte sedimentation rate and percent body fat, were analyzed in both discrete and continuous forms. Because the sedimentation rate was a highly skewed variable, it was normalized by logarithmic transformation for the continuous analyses. The sedimentation rate dichotomy was set at 20 mm/hr or less (normal) and greater than 20 mm/hr (abnormal) by the large-tube Westergren method. Percent body fat was based on height and weight obtained during the examination and was calculated according to the following formula: $\text{Percent Body Fat} = (\text{Weight}[\text{kg}]/\text{Height}[\text{m}]^2)(1.264) - 13.305$. It is recognized that this formula will overstate the percent body fat for very muscular, large-boned men. Percent body fat was trichotomized into less than 10 percent (lean), 10 to 25 percent (normal), and greater than 25 percent (obese), consistent with the Baseline Report. Because of the sparseness of the lean category, it was often necessary to use a dichotomous variable of lean-normal versus obese.

Erythrocyte Sedimentation Rate

The unadjusted contrast of log sedimentation rate means revealed no significant group differences (mean \pm SE=1.620 \pm 0.026 in the Ranch Hand group versus 1.595 \pm 0.021 in the Comparison group, $t=0.73$, $p=0.47$). The geometric mean values were 5.05 and 4.93 for the Ranch Hand and Comparison groups, respectively. Tests of association of dichotomized sedimentation rate, with the covariates age, race, occupation, and personality score, pooled over both groups, were conducted; these summarized data are shown in Table 9-9.

These results showed significant effects of age, with older individuals having a higher frequency of abnormal sedimentation rates than younger individuals, and a significant effect of personality score, with Type B individuals (low personality score) having more sedimentation rate abnormalities. The effect of occupation was of borderline significance ($p=0.080$), with a slightly higher percentage of abnormal values among the enlisted flyers than among officers or enlisted groundcrew. There was no evidence of any association between race and abnormal sedimentation rate.

An analysis of the log sedimentation rate, adjusting for age, race, occupation, and personality score, detected significant effects for all of the covariates except race, as well as a significant age-by-personality score interaction. As in the unadjusted analysis, the adjusted analysis did not reveal any significant difference between the Ranch Hand and Comparison groups ($p=0.412$).

TABLE 9-9.

**Association Between Sedimentation Rate and
Age, Race, Occupation, and Personality Score in the
Combined Ranch Hand and Comparison Groups**

		Sedimentation Rate					
		Normal ≤20mm/hr		Abnormal >20mm/hr			
Covariate	Covariate Category	Number	Percent	Number	Percent	Total	p-Value
Age	Born ≥1942	941	97.9	20	2.1	961	<0.001
	Born <1942	1,263	93.7	85	6.3	1,348	
Race	Black	136	95.1	7	4.9	143	0.999
	Nonblack	2,068	95.5	98	4.5	2,166	
Occupation	Officer	828	95.8	36	4.2	864	0.080
	Enlisted	361	93.3	26	6.7	387	
	Flyer Enlisted Groundcrew	1,015	95.9	43	4.1	1,058	
Personality Score	Low	843	94.0	54	6.0	897	0.026
	Medium	758	96.6	27	3.4	785	
	High	595	96.1	24	3.9	619	

However, in the dichotomous form, sedimentation rate abnormalities were significantly more prevalent in the Ranch Hands than Comparisons (Est. RR: 1.63, 95% C.I.: [1.12,2.38], $p=0.013$); these results are given in Table 9-10.

Logistic regression analysis found significant effects for age and personality score, and the adjusted relative risk of 1.68 (95% C.I.: [1.13,2.49], $p=0.011$), was very similar to the estimated relative risk of 1.63.

TABLE 9-10.

Unadjusted Analysis for
Sedimentation Rate by Group

Group	Sedimentation Rate				Total	p-Value
	Normal ≤20 mm/hr		Abnormal >20 mm/hr			
	Number	Percent	Number	Percent		
Ranch Hand	957	94.2	59	5.8	1,016	0.013
Comparison	1,247	96.4	46	3.6	1,293	

The mean log sedimentation rate in the Original Comparisons was 1.636 plus or minus 0.025, not significantly different from the Ranch Hand mean ($t=-0.45$, $p=0.65$). The regression analysis yielded results very similar to those reported above, with little difference in the adjusted group means. Logistic regression analyses also gave similar results, with significantly more abnormalities in the Ranch Hand group ($p=0.037$).

In summary, there was no difference between groups based upon mean values of the sedimentation rate, unadjusted or adjusted, but both unadjusted and adjusted discrete analyses showed a significantly higher prevalence of sedimentation rate abnormalities in the Ranch Hand group. This finding was opposite to the Baseline findings in which Ranch Hands age 40 or less had significantly fewer sedimentation rate abnormalities than Comparisons, with no group difference in individuals over the age of 40.

Percent Body Fat

The mean percent body fat of Ranch Hands was significantly lower than that of Comparisons ($21.10\% \pm 0.15$ versus $21.54\% \pm 0.14$, respectively; $p=0.037$). Because there were only a few values in the lean category (6 in the Ranch Hand group and 4 in the Comparison group), percent body fat was dichotomized into at most 25 percent (lean and normal) and more than 25 percent (obese) for tests of association between percent body fat and the covariates age, race, and occupation. The results are given in Table 9-11.

TABLE 9-11.

**Association Between Percent Body Fat and Age,
Race, and Occupation in the Combined Ranch Hand
and Comparison Groups**

		Percent Body Fat					
		Lean/Normal ≤25%		Obese >25%			
Covariate	Covariate Category	Number	Percent	Number	Percent	Total	p-Value
Age	Born ≥1942	802	83.4	159	16.6	961	0.005
	Born <1942	1,060	78.7	287	21.3	1,347	
Race	Black	110	76.9	33	23.1	143	0.29
	Nonblack	1,752	80.9	413	19.1	2,165	
Occupation	Officer	719	83.3	144	16.7	863	0.023
	Enlisted	314	81.1	73	18.9	387	
	Flyer						
	Enlisted Groundcrew	829	78.4	229	21.6	1,058	

These data demonstrated the significant effects of age, with a higher percentage of obesity in older men, and occupation, with a higher prevalence of obesity in enlisted personnel than in officers. Race was a noncontributory covariate. The covariate of smoking was unexplored.

An adjusted analysis of percent body fat, with the same covariates, also showed the significant effects of age, occupation, and an age-by-occupation interaction. The adjusted results showed a small, but significantly lower mean level of body fat in the Ranch Hand group (adjusted difference=-0.443 \pm 0.210, $p=0.035$).

With percent body fat dichotomized into obese versus normal or lean, the percent obese was lower in the Ranch Hands than in the Comparisons (18.2% versus 20.2%), but the difference was not significant (Est. RR: 0.90, 95% C.I.: [0.71,1.08], $p=0.25$). Logistic regression analysis also failed to detect a significant group difference (Adj. RR: 0.87, 95% C.I.: [0.71,1.08], $p=0.204$).

Analysis of percent body fat in the Ranch Hands and Original Comparisons gave somewhat different results. The overall difference in means was significant as before: 21.10 plus or minus 0.15 in the Ranch Hand group versus 21.58 plus or minus 0.16 in the Original Comparison group ($t=-2.15$, $p=0.032$). However, the regression analysis detected a statistically significant group-by-race interaction ($p=0.041$). The adjusted difference in mean percent body fat (Ranch Hand versus Comparison) was greater in Black participants (-2.26%)

than in nonblack participants (-0.34%). Of the Original Comparisons (Table G-7 of Appendix G), 20.4 percent were obese, greater than, but not significantly different from, the percent obese in the Ranch Hand group ($p=0.230$). Logistic regression analyses again detected significant age and occupation effects, but it detected no significant interaction between these variables. There was no strong evidence of a group-by-race interaction (models including all two-factor interactions gave a Z-value of 1.19 for the group-by-race interaction). The group effect was not statistically significant (Adj. RR: 0.87, 95% C.I.: [0.70,1.09], $p=0.242$).

In summary, the unadjusted and adjusted tests of mean percent body fat showed a significantly lower value for Ranch Hands; correspondingly fewer Ranch Hands than Comparisons were obese, although this difference was not statistically significant. Few individuals were lean (less than 10 percent body fat). The 1982 Baseline examination found no difference in group means ($p=0.67$), or proportion of abnormalities ($p=0.89$). Further, analyses based solely upon the Original Comparison cohort found the difference in mean percent body fat between the Ranch Hand and Comparison groups to be greater in Blacks than nonblacks.

EXPOSURE INDEX ANALYSES

The exposure index, expressed in equivalent gallons of dioxin-containing herbicide potentially encountered by each Ranch Hand during his tour of duty in Vietnam, was categorized as low, medium, and high. Because it is not possible to assess the relative exposure between occupational groups, and since different cutoff values were used in the three occupational categories, separate analyses were performed within each occupational cohort. A detailed description of the exposure index is found in Chapter 8. Exposure analyses were performed on four of the five general health variables. Only four Ranch Hands were recorded as appearing ill or distressed (two were officers, both in the low-exposure category, and two were enlisted flyers, both in the high-exposure category). Further analysis was not done on this variable.

Self-Perception of Health

Table 9-12 presents dichotomized self-perception of health data by exposure level for the 1,016 Ranch Hands. While these unadjusted contrasts did not reach statistical significance within any of the occupational strata, the linear trend from low to high exposure in the officer cohort of the fair/poor category was of interest, and was subjected to further testing. Although the numbers were small at each exposure level, a test for linear trend led to a borderline significant increase of 2.5 plus or minus 1.3 percent per unit (step) increase in the exposure level category ($p=0.064$).

Logistic regression analyses adjusted for age (dichotomized), race, and personality score (trichotomized) did not detect any significant exposure level effects. The only significant covariate effect found was for age in the enlisted groundcrew cohort. The adjusted relative risk for each occupational stratum is given in Table 9-13.

TABLE 9-12.

**Unadjusted Exposure Index Analysis of
Self-Perception of Health by Occupation**

Occupation	Exposure Index	Self-Perception of Health				Total	p-Value*
		<u>Excellent/Good</u>		<u>Fair/Poor</u>			
		Number	Percent	Number	Percent		
Officer	Low	124	97.6	3	2.4	127	0.17
	Medium	124	95.4	6	4.6	130	
	High	114	92.7	9	7.3	123	
Enlisted Flyer	Low	51	92.7	4	7.3	55	0.83
	Medium	59	90.8	6	9.2	65	
	High	51	89.5	6	10.5	57	
Enlisted Groundcrew	Low	134	87.0	20	13.0	154	0.51
	Medium	146	89.6	17	10.4	163	
	High	121	85.2	21	14.8	142	

*Chi-square tests, 2 d.f.

TABLE 9-13.

**Adjusted Relative Risk of Self-Perception of Health
by Occupation and Exposure Contrast**

Occupation	Exposure Contrast	Adj. Relative Risk (95% C.I.)	p-Value
Officer	Medium vs. Low	2.00 (0.49,8.15)	0.334
	High vs. Low	2.93 (0.76,11.3)	0.119
Enlisted Flyer	Medium vs. Low	1.30 (0.35,4.86)	0.700
	High vs. Low	1.50 (0.40,5.64)	0.549
Enlisted Groundcrew	Medium vs. Low	0.95 (0.47,1.92)	0.882
	High vs. Low	1.21 (0.62,2.35)	0.580

Appearance of Relative Age

The dichotomy of appearance of relative age was assessed for exposure effects in each occupational cohort. These unadjusted analyses, shown in Table 9-14, provided no evidence of a dose-response effect. As can be seen, the number of participants within each stratum appearing older than their stated ages was quite small. The adjusted analyses by logistic regression did not detect any significant exposure or covariate effects.

TABLE 9-14.
Unadjusted Exposure Index Analysis of
Appearance of Relative Age by Occupation

Occupation	Exposure Index	Relative Age				Total	p-Value*
		Younger/Same		Older			
		Number	Percent	Number	Percent		
Officer	Low	125	98.4	2	1.6	127	0.89
	Medium	127	97.7	3	2.3	130	
	High	121	98.4	2	1.6	123	
Enlisted Flyer	Low	52	94.6	3	5.4	55	0.88
	Medium	62	95.4	3	4.6	65	
	High	55	96.5	2	3.5	57	
Enlisted Groundcrew	Low	146	94.8	8	5.2	154	0.82
	Medium	151	93.2	11	6.8	162	
	High	134	94.4	8	5.6	142	

*Chi-square tests, 2 d.f.

Erythrocyte Sedimentation Rate

The sedimentation rate was analyzed both continuously on a logarithmic scale and dichotomously (normal, abnormal). One-way analyses of variance were performed on the sedimentation rate means categorized by occupation and exposure level. These tests showed no significant differences in the officer and the enlisted flyer strata ($p=0.76$, $p=0.64$, respectively). In the enlisted groundcrew stratum the means were marginally different, with the mean sedimentation rate increasing with increasing exposure level, but the differences were not statistically significant ($p=0.12$). When these data were adjusted by an analysis of covariance for age, the difference in mean sedimentation rates in the enlisted groundcrew was less noteworthy ($p=0.33$). Age was positively associated with the mean sedimentation rate in all three occupational strata ($p<0.001$, $p=0.009$, and $p<0.001$, respectively). The adjusted tests are reflected in Table 9-15 (means and confidence limits have been transformed back to the original scale).

A categorical analysis of the sedimentation rate by exposure level for each occupational stratum was also conducted. Differing from the previous continuous analyses, the categorical contrasts revealed a significant exposure effect ($p=0.027$) in the enlisted flyer stratum, albeit with small numbers. These summarized data are shown in Table 9-16.

Adjustment for age, race, and personality score revealed a significant high versus low exposure contrast in the enlisted flyer stratum. The adjusted analysis is fully shown in Table 9-17.

TABLE 9-15.

Adjusted Mean Sedimentation Rates by Occupation

Occupation	Exposure Index, Adjusted Mean, mm/hr (95% C.I.)			p-Value
	Low	Medium	High	
Officer	5.40 (4.71,6.19)	4.78 (4.17,5.47)	4.69 (4.09,5.37)	0.31
Enlisted Flyer	5.10 (4.11,6.33)	6.00 (4.91,7.32)	5.00 (4.04,6.19)	0.41
Enlisted Groundcrew	4.66 (4.10,5.29)	5.09 (4.49,5.77)	5.35 (4.69,6.12)	0.33

TABLE 9-16.

**Unadjusted Exposure Index Analysis of
Sedimentation Rate by Occupation**

Occupation	Exposure Index	Sedimentation Rate				Total	p-Value*
		Normal ≤20mm/hr		Abnormal >20mm/hr			
		Number	Percent	Number	Percent		
Officer	Low	117	92.1	10	7.9	127	0.27
	Medium	125	96.2	5	3.8	130	
	High	119	95.9	5	4.1	123	
Enlisted Flyer	Low	53	96.4	2	3.6	55	0.027
	Medium	62	95.4	3	4.6	65	
	High	48	84.2	9	15.8	57	
Enlisted Groundcrew	Low	142	92.2	12	7.8	154	0.290
	Medium	156	95.7	7	4.3	163	
	High	136	95.8	6	4.2	142	

*Chi-square tests, 2 d.f.

TABLE 9-17.

**Adjusted Relative Risk of Sedimentation Rate
by Occupation and Exposure Contrast**

Occupation	Exposure Contrast	Adj. Relative Risk (95% C.I.)	p-Value
Officer	Medium vs. Low	0.47 (0.16,1.41)	0.177
	High vs. Low	0.50 (0.17,1.52)	0.226
Enlisted Flyer	Medium vs. Low	1.28 (0.21,7.96)	0.790
	High vs. Low	4.97 (1.02,24.2)	0.047
Enlisted Groundcrew	Medium vs. Low	0.76 (0.28,2.06)	0.592
	High vs. Low	0.54 (0.19,1.49)	0.234

Percent Body Fat

Exposure analyses of percent body fat were done using both linear models and logistic regression. One-way analyses of variance for means found no statistically significant exposure differences in the occupational cohorts. These statistics are presented in Table 9-18.

TABLE 9-18.

Unadjusted Means of Percent Body Fat by Occupation

Occupation	Exposure Index, Mean \pm SE			p-Value
	Low	Medium	High	
Officer	20.99 \pm 0.36	21.11 \pm 0.41	21.26 \pm 0.36	0.88
Enlisted Flyer	20.65 \pm 0.55	21.26 \pm 0.77	21.59 \pm 0.77	0.65
Enlisted Groundcrew	20.91 \pm 0.42	21.43 \pm 0.41	20.79 \pm 0.44	0.53

Linear models including age, race, and two-factor exposure level-by-covariate interactions found no significant difference in the adjusted exposure level means for percent body fat. The effect of age was significant in the officer cohort ($p=0.003$), and of borderline significance in the enlisted groundcrew stratum ($p=0.064$). Race was nonsignificant throughout all the tests.

The unadjusted categorical assessment of percent body fat, shown in Table 9-19, revealed no significant exposure effects. However, in the enlisted flyer stratum, a test for linear trend in the proportions gave a borderline significant result ($p=0.054$), with an estimated step increase of 6.8 plus or minus 3.6 percent per unit increase in exposure-level category. An adjusted analysis by logistic regression did not reveal significant exposure level effects but did detect significant effects of age in the officer and enlisted groundcrew categories.

In summary, detailed exposure analyses were performed on four of five dependent variables used to assess general health status. Only a very few of the tests approached statistical significance (multiple comparisons notwithstanding); of these, three associations suggested a trend of adverse effects from low to high exposure; but only one was statistically significant, and there was no consistency across occupational strata (health perception in officers, $p=0.064$; sedimentation rate in enlisted flyers, $p=0.027$; and percent body fat in enlisted flyers, $p=0.054$). These results were relatively comparable to the negative exposure findings in the Baseline Report.

TABLE 9-19.

**Unadjusted Exposure Index Analysis of
Percent Body Fat by Occupation**

Occupation	Exposure Level	Percent Body Fat				Total	p-Value*
		Lean/Normal ≤25%		Obese ≤25%			
		Number	Percent	Number	Percent		
Officer	Low	104	81.9	23	18.1	127	0.76
	Medium	110	84.6	20	15.4	130	
	High	100	81.3	23	18.7	123	
Enlisted Flyer	Low	50	90.9	5	9.1	55	0.14
	Medium	53	81.5	12	18.5	65	
	High	44	77.2	13	22.8	57	
Enlisted Groundcrew	Low	126	81.8	28	18.2	154	0.88
	Medium	131	80.4	32	19.6	163	
	High	113	79.6	29	20.4	142	

*Chi-square tests, 2 d.f.

LONGITUDINAL ANALYSES

Two variables, self-perception of health and sedimentation rate, were prescribed to assess the longitudinal differences between the 1982 Baseline examination and the 1985 followup examination. Both variables were analyzed in the discrete form. The four categories of perception of health were reduced to normal (excellent/good) and abnormal (fair/poor). The respective laboratory norms of 12 or less mm/hr and more than 12 mm/hr for the Baseline sedimentation rates, and 20 or less mm/hr and more than 20 mm/hr for the followup examination were used to categorize the sedimentation rate data into normal and abnormal groups. The off-diagonal data (normal to abnormal, abnormal to normal) from the two examinations were contrasted by group membership, a process equivalent to testing for a group-by-time-by-clinical endpoint interaction. The results of these tests, unadjusted for covariates, are given in Table 9-20.

These analyses showed an equivalence of the change in self-perception of health in the two groups between examinations, but a highly significant group difference in the change in sedimentation rate abnormalities. The latter was explained by the fact that the Baseline examination determined a significant excess of sedimentation rate abnormalities in the Comparisons whereas at the followup examination, the Ranch Hands had a significantly higher proportion of abnormalities. Perhaps as a related fact, it is recognized that the sedimentation rate laboratory test procedure changed to a more sensitive one at the followup examination.

TABLE 9-20.

**Longitudinal Analysis of Self-Perception of Health and Sedimentation Rate:
A Contrast of Baseline and First Followup Examination Abnormalities**

Variable	Group	Baseline Examination	Followup Examination		Odds Ratio (OR*)	p-Value (OR _{RH} vs. OR _C)
			Abnormal	Normal		
Self-Perception of Health	Ranch Hand	Abnormal	62	127	0.21	0.84
		Normal	27	750		
	Comparison	Abnormal	49	124	0.23	
		Normal	28	936		
Sedimentation Rate	Ranch Hand	Abnormal	17	16	2.44	0.002
		Normal	39	899		
	Comparison	Abnormal	14	37	0.73	
		Normal	27	1,061		

*Odds Ratio:
$$\frac{\text{Number Normal Baseline, Abnormal Followup}}{\text{Number Abnormal Baseline, Normal Followup.}}$$

SUMMARY AND CONCLUSIONS

General physical health was evaluated by five measures, three of which were subjective (self-perception of health, appearance of distress, and appearance of relative age), and two of which were objective (percent body fat and sedimentation rate). Table 9-21 presents a summary of all the unadjusted and adjusted analyses of these five variables.

The Ranch Hands rated their health as fair or poor more often than the Comparisons (9.1% versus 7.3%, respectively), but this difference was not significant by categorical testing. However, further analysis revealed a significant group-by-occupation interaction; differences were largely confined to the enlisted groundcrew category. Both the Ranch Hand and Comparison groups noticeably improved their perceptions of health from the 1982 Baseline examination.

Only 10 individuals were reported as appearing acutely ill or distressed at the followup examination, 4 were Ranch Hands and 6 were Comparisons. This difference was not statistically significant and the data were insufficient for adjusted analyses.

TABLE 9-21.

Overall Summary Results of Unadjusted and Adjusted
Analyses of General Health Variables

Variable	Unadjusted		Adjusted	
	Categorical	Mean	Categorical	Mean
Self-Perception of Health	NS	--	****	--
Appearance of Illness/Disstress	NS	--	-- ^a	--
Appearance of Relative Age	NS	--	****	--
Sedimentation Rate	0.013	NS	0.011	NS
Percent Body Fat	NS	0.037	NS	0.035

--Analysis not performed.

****Group-by-covariate interaction.

^aAnalysis not possible due to sparse data.

Appearance of relative age, as determined by the examining physician, showed 1.6 percent of the Ranch Hands appearing younger than their stated age, 94.3 percent appearing the same, and 4.1 percent appearing older (as contrasted to 0.7%, 95.4%, and 3.9%, respectively, in the Comparison group). There was a significant group-by-occupation interaction, but none of the estimated relative risks for the occupational categories was significant. This observation at the followup examination contrasted with the significant tendency at the Baseline for a higher percentage of Ranch Hands than Comparisons to appear younger than their stated ages.

The geometric mean sedimentation rates (5.05 mm/hr Ranch Hand versus 4.93 mm/hr Comparison) did not differ significantly by group, either unadjusted or after adjustment for age, race, occupation, personality score, and an age-by-personality score interaction. However, in the dichotomous form, 5.8 percent of the Ranch Hands had sedimentation rate abnormalities as contrasted to 3.6 percent in the Comparison group. This difference was significant by both unadjusted and adjusted tests. Also, this finding was opposite to that of the Baseline examination, where it was noted that younger Comparisons had significantly elevated sedimentation rates.

The mean percent body fat of the Ranch Hands was significantly lower than the Comparisons (21.10 ± 0.15 , 21.54 ± 0.14 , respectively, $p=0.037$), and was of nearly the same magnitude after adjustment for age, race, and occupation. However, both unadjusted and adjusted categorical tests did not reveal significant group differences, although the percent obese was lower in the Ranch Hands than in the Comparisons. No group differences in percent body fat were noted at the Baseline examination.

Detailed exposure analyses were done on four general health variables (appearance of acute distress was too sparse for testing). Only one analysis demonstrated statistical significance, i.e., a positive association of sedimentation rate abnormalities with increasing exposure in the enlisted flyer cohort. Overall, no consistent pattern of exposure effects was discernible, and the exposure findings at the third-year followup were similar to the findings at Baseline.

Longitudinal differences between the 1982 Baseline and the 1985 followup examination were assessed by analyses of two discrete variables, self-perception of health and sedimentation rate. Perceived health showed no significant group differences over time, but both the Ranch Hand and Comparison groups paradoxically reported symmetrical improvements in their perceptions over the 3-year period. The sedimentation rate analysis revealed a highly significant group difference ($p=0.002$), due to a reversal of findings between examinations, i.e., a significant detriment in the younger Comparisons at the Baseline versus a significant detriment in the Ranch Hands at the followup. The cause(s) and biological relevance of this observation are unclear.

In conclusion, a nonspecific assessment of general physical health has shown relatively close similarity between the Ranch Hand and Comparison groups, with the Ranch Hands continuing to perceive their health more negatively than the Comparisons, having a slightly more favorable percent body-fat proportion, but a higher proportion of abnormal sedimentation rates that reflects a marked change since the Baseline examination. These findings must be placed in context with the organ and system-specific evaluations found in the succeeding chapters.

CHAPTER 9

REFERENCES

1. Jenkins, C.D., R.H. Rosenman, and S.J. Zyzanski. 1974. Prediction of clinical coronary heart disease by a test for the coronary-prone behavior pattern. New Eng. J. Med. 290(23):1271-1275.